‘A New World… Out of Nothing’: review of an interdisciplinary workshop

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Abstract *The inter-disciplinary workshop, entitled ‘A New World… Out of Nothing’ took place at the University of Warwick during November 2016. This critical review will explore the rationale for the event and its features, drawing on the organiser's views on inter-disciplinarity and communicating pure mathematics to a wider audience. The workshop was organised by Francesca Iezzi, who has recently finished a PhD in pure Mathematics and is a fellow of the supporting institutions, the Warwick Institute for Advanced Study (IAS) and the Warwick Institute for Advanced Teaching and Learning (IATL).*

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Background and Rationale

As a fellow at IAS and IATL, I am very interested in the concept of inter-disciplinarity, and, as a mathematician, I am particularly concerned about the role of mathematics in the development of knowledge, and of society in general. Communicating research progress in pure mathematics is far from being easy, due to the abstract nature of the subject, and the fact that often mathematical research is not aimed at being ‘useful’, but is rather aimed at discovering an intrinsic beauty. In this sense, common features can be drawn between mathematics and the arts. Furthermore, although pure mathematics is often considered a science, it differs from the empirical sciences, both in scope and research methodologies. In addition, there is often an ingrained (mis)conception of mathematics as a collection of rules and formulae to be memorised, which ignores the elegance and creativity underpinning mathematical research. On the other hand, this perception can be reinforced by the process of pure mathematics research, which does not always encourage communication

with other disciplines. In my opinion, all these issues have contributed to forming a barrier between pure mathematics and other areas of knowledge.

For these reasons, I decided to design an event aimed at presenting the creative side of mathematical research, and how an abstract mathematical concept – the discovery of non-Euclidean geometries – has influenced and pervaded many different areas of knowledge, from physics to the arts. The debate about the existence of non-Euclidian geometries traces back to the ancient era, even before Euclid published his book '*Elements*'. The Greek mathematician had developed what is now known as 'Euclidean geometry' based on a collection of axioms. The most famous of such axioms is what is known as 'the fifth postulate'.[i] For centuries mathematicians had been convinced that the fifth postulate depended on the other axioms and had tried to prove this. Eventually, in the nineteenth century, János Bolyai and Nikolai Ivanovich Lobachevsky, independent of each other, published treaties to introduce an alternative geometry (which was later called hyperbolic geometry) where all Euclid's axioms, but the fifth postulate, hold. Other non-Euclidian geometries have been discovered after that. Bolyai ended his work by stating that it is impossible to decide using abstract mathematics alone whether the geometry of the Universe is Euclidian or non-Euclidian, and that this is a task for the Physical sciences. In correspondence with his father, he said he had created 'a new, different world, out of nothing', hence the title of the event. The discovery of non-Euclidean geometries has opened the way to many research areas within mathematics (my own research area among them) and has influenced many areas of knowledge. Most famously, it forms the basis of Einstein's theory of special relativity, as well as inspires the work of artists and writers.

Structure of the Workshop

The workshop was structured around four talks, an activity and a panel discussion. In the first talk Professor Jeremy Gray, historian of mathematics (University of Warwick) introduced the discovery of hyperbolic geometry. The second talk was given by the physicist Professor Robert Lambourne (Open University) explaining the Minkowski space-time and Einstein's theory of special relativity, which is based on a 4-dimensional non-Euclidian geometry. The third talk given by Dr Mairi Walker (University of Edinburgh), who works in public engagement with mathematics, was aimed at giving an idea about how hyperbolic geometry has influenced the work of some artists, such as Maurits Cornelis Esher. The fourth talk was given by Professor Hugo Parlier (University of Fribourg), a mathematician whose research area is very

closely related to hyperbolic geometry. Rather than showing further applications of non-Euclidian geometries, this talk was aimed at showing how a mathematician would approach a research problem. Puzzles were used to provide a simple introduction to current object of study in Geometry, whose technical name is 'Moduli Spaces'.

After the talks a panel discussion took place on how to communicate science to a non-expert audience. The panellists were the four speakers, who had all been involved in many widening participation activities. The workshop ended with an activity led by Dr Mairi Walker, offered to 40 people. Participants were asked to draw their own 'masterpiece' using concepts of hyperbolic geometry.

Evaluation and Feedback

Overall, the event surpassed my own and participants' expectations. More than a hundred people attended, and I received formative and positive feedback. The audience was composed of students, staff and guests, from many different disciplinary backgrounds (including people from the sciences, the arts and humanities, engineering and economics). My initial plan was based on fifty attendees, with an alternation of talks and interactive activities. Since over two hundred people registered, the original schedule was modified to accommodate a larger number of participants. Participants provided feedback through evaluation forms on the day of the event (Appendix A).

Participants' familiarity with the topic ranged from beginner to expert. The main reasons for attending the workshop were general interest in the topic, interest in interdisciplinary dialogue and in the science-art collaboration, or, in the case of mathematicians, an interest 'to see the topic in context of the wider history of mathematics and other subjects' (Mathematics Undergraduate). Other participants were interested in the 'intersection of cognitive science, visualization and physics' (staff member from Physics) or were seeking to gain a new perspective on their own research topic. The workshop inspired some participants to learn more about non-Euclidean geometry. For example, a PhD student in Warwick Business School wrote: 'I liked how I visualised hyperbolic surfaces, I don't know if it will be useful in my research but I really liked imagining that.'

Inspiring Inter-disciplinary thinking

Participants mentioned many inter-disciplinary ideas, which they thought were worth expanding on, or might inspire their research. The idea of the perception and representation of space and time (sparked from the talk on relativity) struck more than one person. Participants with humanities backgrounds commented on 'how little we actually understand about space of time', another that 'I have always wondered about where we position ourselves in time and space', and one participant would 'reconsider the representation of time and space in cinema and photography.'

Other ideas that were sparked included 'hyperbolic space could perhaps be used in surrealism and the analysis/interpretation of certain designs of dream sequences' (Undergraduate, Film and Television). A Masters History student appreciated the introduction to the theory of Relativity stating 'the historic change in perception over relativity can be effectively used to shed light on writing more holistic global histories.'

Appreciating mathematics and the Arts

Attendees from both science and arts backgrounds appreciated the links between mathematics, art and imagination. Participants were 'fascinated by the aesthetic beauty inspired by mathematics' (staff, from the Medical School), with one insightful quotation that 'what mathematicians and artists find beautiful, others will also find beautiful: the key to science' (staff, from the Warwick Manufacturing Group).

Attending the workshop caused some participants to consider mathematics differently. Major themes in participants' feedback included realising the role of mathematics in a wide range of disciplines, beyond simple calculations; the reception of mathematical or scientific discovery in the arts; the role of intuitive visual creativity in mathematics; and the influence of geometry in many areas of knowledge, such as philosophy, the arts, and the physical sciences; a PhD student in (Warwick Manufacturing Group) commented: 'Geometry links as a common language in many areas. It is just hard to explain how, what and when'.

Communicating Mathematics

Participants also reflected on effective ways to communicate new concepts. A member of Warwick Manufacturing Group, recognised the 'importance of imagination/intuition as a route into communicating new complex subjects', and a PhD Theatre Studies student pointed out the

role of 'patterns, visualisation and mappings' in the construction of knowledge. Others pointed out the importance of practical examples in communicating Mathematics, highlighting the tension between intrinsic interest and focus on applications. One of the speakers reflected:

> I had discussions with some participants pertaining to a recurring theme in discussing math outreach, which is the relationship between "pure" mathematics and its applications. The position I generally take is to say that I'm arguing for intrinsic interest in mathematics as a viable way of getting people interested but at the same time, I also agree that possible applications are exciting and the argument for saying that math is important for understanding how the world works is also extremely pertinent. The people I talked to agreed with this, but it should be noted that participants are not a good sample set as they purposefully signed up for the workshop.

The interactive panel discussion reinforced ideas about the value of inter-disciplinary thinking, dialogue between disciplines, and public engagement activities. A Mathematics PhD student said they learnt 'that there are great ways to communicate maths to non mathematicians', and an attendee with a background in philosophy said the workshop made them value the role of outreach and public engagement, and made them reflect on the 'range of modes of engagement with the subject'. Most attendees said they would be interested in taking part in similar events, and some were interested in a module covering the topic of the workshop.

Reflections on Improvements

After reading the feedback forms and a personal reflection, I identified steps for improvement in the planning and organisation process. Similar future events would benefit from slightly shorter talks with more opportunities for different learning activities and interaction. Participants appreciated post-seminar questions and interaction, and would have liked more time to engage in these activities. Having longer breaks in between talks would have provided opportunities to internalise new concepts and discuss. A brief introduction to each talk, providing background information and explaining my reason for including that topic would have helped participants to better appreciate the relevance of each talk. Publishing talk abstracts on the website beforehand would have also been useful.

It is important to consider that participants of interdisciplinary workshops may not have a science background; therefore efforts to communicate specialised topics to a broader, less informed audience are essential. Additional topics for talks, which would encourage greater participation from the Arts and Humanities, include the influence of non-Euclidian geometries or relativity on Philosophy and Literature. However, due to the difficulty in finding available experts on those particular topics, this was not possible at the time.

Conclusions

Overall, I am pleased with the event, as a step towards creating dialogue between different disciplines, and making people reconsider the importance, elegance and beauty of mathematics. Furthermore, the large number of registrations and the interest of attendees in similar events made me aware of the demand for dialogue and exchange of ideas between disciplines.

As a step forward in that direction, I have invited some of the attendees (on a voluntary basis) to take part in a discussion about the role of (pure) mathematics in inter-disciplinary approaches. The discussion will also touch on some of the topics which came out of the feedback forms, such as the common perception of mathematics and the best ways to communicate the subject, the perception and representation of space and time, and the idea of aesthetics within mathematics and arts.

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[i] Euclid's fifth postulate is also known as the *parallel postulate*. In the context of Euclidian 2-dimensional geometry, the postulate can be stated as follows: given a line *l* in the plane and a point *P* which is not on the line *l*, there exists a unique line through the point *P* which is parallel to the line *l.*

Appendix A

A New World… Out of Nothing: Workshop Feedback Form

Department

UG (year) Master PhD Staff Guest
Other

Reason for attending the event

What did you expect of the event?

Where your expectations fulfilled?

How familiar where you with the topic? (rate 1to 5)

Did you find the talks pitched at the right level and easy to follow? (rate 1 to 5)

Did you find the talks stimulating? (rate 1 to 5)

Did the event transmit some interest in the topic and eagerness to learn more? (rate 1 to 5)

Did you find any concepts/ideas which might turn useful in your study/research/profession? If yes, what?

Did the event make you think differently about Mathematics as a discipline and the way it interacts with other disciplines? (rate 1 to 5)

How?

Did the event change your opinion about inter-disciplinarity? (rate 1 to 5)

How?

What is the main thing you learnt from the event?

What is the thing you liked most? Why?

What did you find least useful?

How did you like the format of the event? (rate 1 to 5)

Would you suggest any improvements?

Would you be interested in taking part in similar events? (Yes/No)

Would you be interested in taking part in a module centred around the topics of the workshop? (Yes/No)

Any additional comments?

FINAL ACTIVITY

Did you attend the final activity? (Yes/No)

Did you find the activity useful/stimulating? (rate 1 to 5)

Additional comments

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